

The Ecology and Behavior of *Nautilus pompilius* in the Philippines

BY

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(2 Plates; 2 Text figures)

INTRODUCTION

OBSERVATIONS WERE MADE ON various aspects of the ecology and behavior of *Nautilus pompilius* Linnaeus, 1758, during the course of a study of reproduction of the animal where it occurs in the Philippines. There have been few previous studies of living *N. pompilius*, studies on living animals in the field having been done on only two previous occasions. WILLEY (1902) worked in the New Hebrides for 3 years, and DEAN (1901) did a much shorter study in the Philippines. Observations on aquarium specimens of a different species (*N. macromphalus*) have been made by BIDDER (1962) and CATALA (1964). MOSELEY (1879) described the activities of a single specimen of *N. pompilius* in a bucket, while BIDDER (1962) observed one specimen of *N. pompilius* "immediately after it was brought to the surface", but did not further differentiate its activities from those described for *N. macromphalus*.

The present observations were made on animals trapped and kept in holding cages in the ocean, as well as on animals held in an aquarium. Studies were made in the water with the aid of SCUBA gear. Field studies were done from June until mid-October, 1971.

MATERIALS AND METHODS

Specimens were caught in traps set in Tañon Strait, which lies between the islands of Negros and Cebu (Figure 1), and were kept for months at a time in holding cages at 60 m. Some animals were also kept for as long as 2 weeks in holding cages set at 10 m and at 25 m, where observations were made by SCUBA diving. Observations of free swimming animals were also made by SCUBA diving. Animals kept in aquaria with a continuous flow of seawater remained healthy and reactive so long as the water was cooled to 23° C, but field conditions precluded cooling

for more than 48 hours. All animals were fed at least every other day.

GEOGRAPHICAL DISTRIBUTION

Two coastal areas of the island of Negros were surveyed in an attempt to ascertain the distribution of *Nautilus pompilius* in the area. Along one, on the northern coast of Negros Occidental between Escalante and Cadiz (Figure 1), *N. pompilius* is seldom, if ever, encountered alive. Empty beach washed shells are occasionally found but the animal is never trapped alive. Stories were persistent among the fishermen of frightened animals deserting their shells. These same fishermen brought in the pelagic octopus, *Tremoctopus violaceus* della Chiaje, 1830, caught near Bantayan Island, saying this was the animal which lived in *Nautilus* shells. It is interesting to note that the fishermen call this octopus by the local name for *Nautilus* ("lagang"), instead of by the name they usually use for an octopus ("cogeta"). From extensive questioning, and our own field search, it appears that if *N. pompilius* occurs in these waters at all, it is certainly rare.

The southern coast of Negros was also surveyed from Bais City on the east, to Bayawan on the west coast (Figure 1). Here *Nautilus pompilius* is encountered as an incidental catch in the local fish traps. These bamboo fish traps are not baited, and are left in place at a depth of 60 to 120 m for a period of 1 to 3 weeks. Estimates given by the fishermen of the frequency of *N. pompilius* catches in the fish traps show that it may be more abundant on the southwest coast of Negros around Bayawan, where an average of 20 per year are caught, than in the southeast portion of the coast from Dumaguete to Siaton (Figure 1), where an average of 7 specimens were encountered per year per trap. Animals purchased in this region were

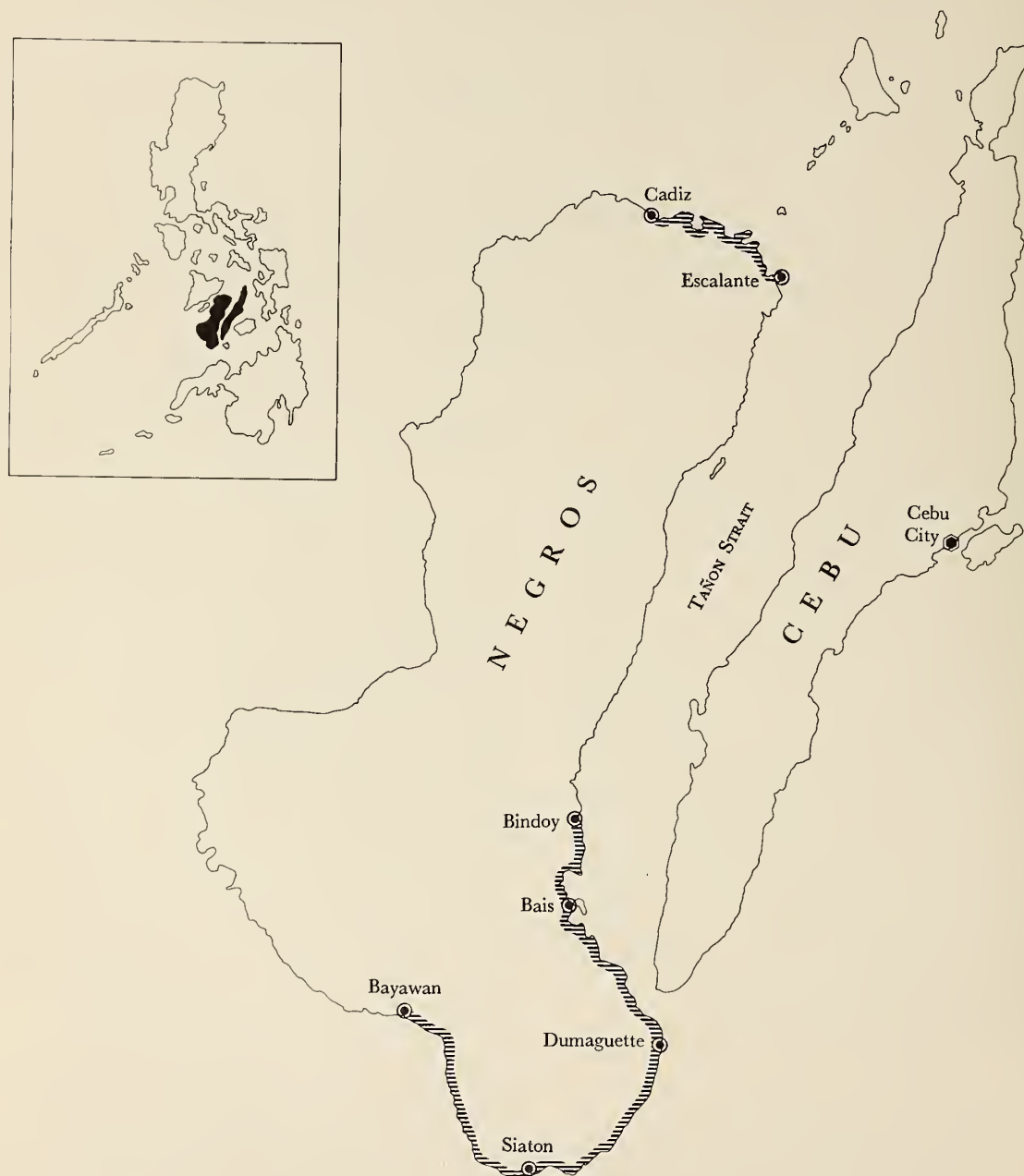


Figure 1

Negros Island, the Philippines, where work on *Nautilus pompilius* was undertaken. Shaded areas of coast represent survey areas. Inset shows Negros and Cebu (black) in relation to rest of Philippine Islands

positively identified as *N. pompilius*. There were no stories here of *N. pompilius* abandoning its shell.

Four fishermen who trap exclusively for *Nautilus pompilius* were eventually located. Philippine fisheries biologists, university scientists and shell collectors had indicated no knowledge of living *N. pompilius* being taken anywhere in the islands, and the finding of these fishermen marked the discovery of a good supply of *N. pompilius* for the first time in 70 years. DEAN (1901) had worked with fishermen near Bais, where *N. pompilius* is no longer known as a commercial animal. TALAVERA & FAUSTINO, writing in 1931, state that at that time there was no longer any commercial fishing of *N. pompilius* in the Philippines.

At present, 4 fishermen from Negros Oriental set traps near Tinaogan Reef, north of Bindoy (Figure 1) ($9^{\circ}48'N$, $123^{\circ}10'E$). Bobos — traditional bamboo fish traps similar to those described by DEAN (1901) — are baited with fresh chicken, fish or pork and set on the bottom, from 60 to 240m deep. The traps are pulled each morning, and although catches may range from 0 to 19 *Nautilus pompilius* per trap, the average daily haul is 5 specimens per trap. The meat of the animal is sold in the local market, and shells are shipped to Cebu City where they are wholesaled by shell dealers. However, the overwhelming majority of *N. pompilius* shells shipped from the Philippines each year have been found during the typhoon season washed up on shore in regions such as the island of Bohol. Bohol lies southeast from the island of Cebu.

ECOLOGICAL DISTRIBUTION

The bobos used by the nautilus fishermen are set near coral reef areas where the bottom drops from 40m to approximately 240m within a mile from shore. The Tañon Strait deepens to 400 - 600m a short distance beyond. It is likely that *Nautilus pompilius* could be found in the deeper regions, but the physical effort of hauling up traps from these depths precludes any trapping there. Fishermen in the area report the bottom environment on the north side of Tinaogan Reef to be rocks and coral heads to about 90m, and mud to limits of their trapping there (approximately 150m). The bottoms of traps brought up sometimes drip a grey mud.

In experimental trapping at various depths, no *Nautilus pompilius* were ever captured shallower than 58m. Experiences with the animals in holding cages, aquaria, and experimental release observed with SCUBA gear, as well as in their transport from the field, strongly suggested that temperature limits vertical distribution.

Table 1 summarizes trapping data for a 6-week period between August 8, 1971 and September 15, 1971. Most traps are set between 80 and 180m where catches are

Table 1

Records of *Nautilus pompilius* caught in traps near Bindoy, Negros Oriental from August 8 to September 15, 1971

Depth (meters)	Number of <i>Nautilus</i> per haul average	range	Number of hauls
58 - 70	1	0 - 3	3
71 - 90	4	0 - 10	17
91 - 110	6	0 - 19	20
111 - 130	5	0 - 12	48
131 - 150	3	1 - 9	12
151 - 170	7	0 - 15	13
171 - 190	5	0 - 10	13
191 - 210	4	0 - 7	2
211 - 230	6	4 - 8	4
231 - 250	5	0 - 9	7
260	2		1

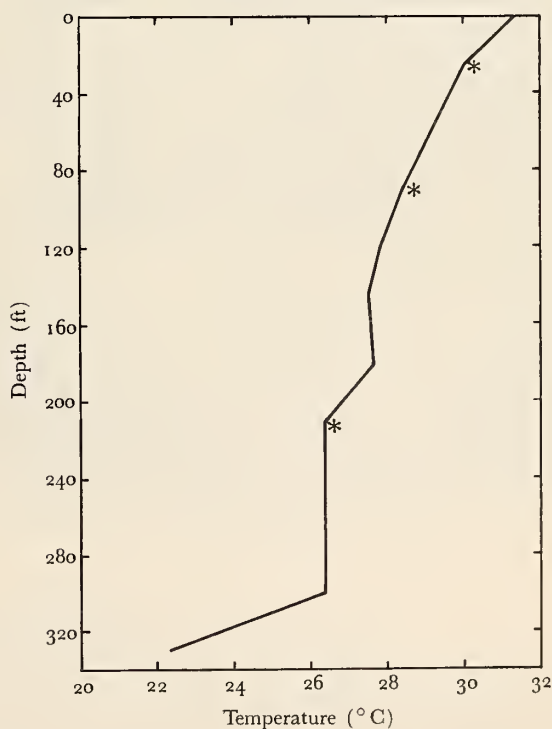


Figure 2

Morning temperatures at holding cage sites (*) and trapping areas, Tañon Strait, September 2 and 3, 1971

consistently good, and the depths convenient for working. Figure 2 shows temperatures taken at various depths during a 2-day period in early September 1971. The data indicate that *Nautilus pompilius* lives at depths where water temperature may be as much as 9° C lower than in the more shallow waters adjoining.

ANOMALOUS DISTRIBUTION OF SEXES

In the 6-week period between early August and mid-September, 1971, 534 specimens were caught in baited traps, and less than 5% of these were females. Eight chance catches (*i. e.*, from an ordinary fish trap or hook and line) were brought in from the southern coast of Negros during July and August. Five of these, or over 60%, were females. Baited traps were set 3 times in one of these locations just south of Dumaguete that had yielded most of the females, in an attempt to determine whether the composition of the population differed there, but no *Nautilus pompilius* at all were caught on these occasions.

WILLEY (1902) experienced a similar, though less drastic, reduction of females in the animals he trapped in New Britain. Approximately one-third of the *Nautilus pompilius* he trapped there over a period of 9 months were females.

Trapping data covering an entire year are being obtained in the present study. These data will show if the low percentage of females caught is a seasonal phenomenon.

COMMENSALS

Commensal copepods, identified as *Anchicaligus nautili* (Willey, 1896), were numerous on the interior aspect of the ala infundibulae, that is, the mantle flaps that lie at the rear of the hood area dorsolaterally and which regulate water intake. *Anchicaligus nautili* were also commonly found in the posterior dorsal portion of the funnel.

Although the vast majority of *Nautilus pompilius* shells are free of settled animals, 2 living specimens were found

with attached barnacles. One had a balanoid type barnacle on the rear of its shell. Another had a stalked barnacle attached about midline ventrally. These shells were accidentally discarded, so further identification of the barnacles was not possible.

The kidneys of freshly killed animals were examined at 500× magnification under a dissecting microscope, and no evidence of mesozoan infestation was found.

DIURNAL ACTIVITY

Experimental trapping near Bindoy, Negros Oriental, confirmed the observation that activity is diurnal (WILLEY, 1902). Baited traps placed out during daylight hours (7 AM to 5 PM) at depths from 110 to 180m, caught no *Nautilus pompilius*, while those similarly placed for 24 hours produced average yields.

Nautilus pompilius kept in holding cages in the ocean at 10 and 25m and observed with SCUBA gear, were occasionally seen eating dead fish placed in the cage during the day. However, most feeding activity was during the night.

In the aquarium, *Nautilus pompilius* usually rested quietly during the day, attached by the distal portion of one or more tentacles to the wall of the aquarium (Figure 3). In the holding cages, where chicken wire provided little support, animals often attached their tentacles to one another's shell. Where portions of the holding cages were lined with burlap, the animals frequently hid in the folds during the day.

It is highly likely that the normal daytime activity of *Nautilus pompilius* is to remain attached to coral rubble or crevices in its natural habitat. Not only did animals usually remain attached during the day when in captivity, but field experiments lent further support to this hypothesis. A healthy *N. pompilius* was released above a sloping coral reef, and swam slowly down at an angle until it came to rest on the reef, where it fastened itself to a coral head and rested quietly, much as it had been observed to do in the aquarium. This behavior was elicited each time it was removed by a diver and released again

Explanation of Figures 3 to 6

Figure 3: *Nautilus pompilius* in daytime resting pose, one tentacle fastened to wall of aquarium

Figure 4: *Nautilus pompilius* beak compared to contour of break in shell of young male *Nautilus pompilius*

Figure 5: Comparison of normal shell of female *Nautilus pompilius*, left, with a similar shell whose contour has been severely altered by bites

Figure 6: *Nautilus pompilius* in aquarium with shortened tentacles



Figure 3



Figure 4



Figure 5



Figure 6

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